

Diphtheria Immunity Status In Montgomery County School Seniors and Adults

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DIPHtheria, once primarily a disease of infants and young children, has been increasing among adults and teen-aged children over the past 20 years (1-4). The shift in age-specific morbidity rates can be traced to markedly decreasing exposures to virulent *Corynebacterium diphtheriae*. The almost universal artificial immunization of infants and children has resulted in less frequent natural immunity among adults.

Somewhere between the adult and the child, however, lies a zone where the protection of unreinforced early immunization begins to wear off. Outbreaks of diphtheria in Detroit, Mich., Albuquerque, N. Mex., and South Carolina in the fall of 1956, while this study was still in the planning stages, pointed up the importance of continued awareness of the disease as a public health problem (5, 6). It also re-emphasized the value of current data on the relative immunity of various population segments in anticipating and preventing outbreaks.

In this study we undertook specifically to determine the relative immunity to diphtheria of the young adult population in an area where only 2 cases, both in white men in their early twenties, have been reported during the preceding 2 years. The study was conducted in Montgomery County, Md., during January and February 1957.

The county, principally a suburban residential center, is northwest of the District of Columbia and has an area of about 525 square miles. Its population, growing at a prodigious

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rate in the postwar period with the influx of Government workers, is nearly 300,000. Of these, 6 percent are Negro. The county has the highest per capita income in Maryland.

Information gathered at the time of preschool conferences over the past 4 years reveals that about 92.5 percent of Montgomery County children have been actively immunized against diphtheria prior to registering for school, and the remainder are almost all given primary immunizations at this time (7). However, because of the large population influx, the inadequacy of transferred school health records, and basic doubt as to the duration of immunization in infancy and early childhood (8), the status of children finishing high school has been heretofore unknown. With the approval of the Montgomery County Medical Society and the superintendent of schools and the aid of the Maryland State Department of Health, the Montgomery County Health Department planned to give Schick tests to all 12th grade students in the county's nine high schools.

Procedure

Several weeks prior to the testing in the schools, each student was given a letter explaining the objectives of the testing program and the significance of the individual reactions, and requesting his parents' permission to give the Schick test. The response to the letter varied from 65 percent to 100 percent of the enrollment in different schools.

The actual testing and reading of the reactions was done by a single health department physician. The antigens used, obtained from the biologic laboratories of the Massachusetts Department of Public Health, consisted of diluted diphtheria toxin (0.02 MLD per 0.1 cc. dose) and purified diphtheria toxoid (0.008 Lf per 0.1 cc. dose) for use as the biological control.

Purified diphtheria toxoid was used in the control test to eliminate pseudoreactions caused by heated diphtheria toxin when used as a control. Possibly the heating process used in destroying the diphtheria toxin so alters the other proteins present that they are no longer capable of causing the reactions of the unheated material (9). The amount of toxoid used in each 0.1 cc. dose, though somewhat empirical, is gen-

erally accepted as a more than satisfactory substitute for the heated toxin (10), and the intradermal skin reaction gives an index to the expected local and systemic reactions from a large dose of diphtheria toxoid.

A carefully measured 0.10 cc. of the dilute Schick toxin was injected intradermally in the left forearm, and the same amount of the control toxoid was injected into the right forearm after both surfaces had been prepared with alcohol.

For administrative reasons, the tests were read at 48 or 72 hours rather than at 96 or 120 hours as is commonly recommended when a control test is not used (11), and reactions were recorded in terms of actual measurement of the greatest diameter of induration at both the test and control sites. Test reactions of 10 mm. diameter or more, which were more than twice the size of the control reaction, were considered positive. To allay unnecessary anxiety, each child was given a printed interpretation of his particular reaction to the test, and the tester individually discussed the significance of each positive and allergic (control positive) reaction with the student.

While it is recognized that the use of dilute diphtheria toxin and toxoid for the testing actually gives subjects a small amount of immunizing antigen, sufficient to produce immunity in borderline susceptibles and probably cause a significant rise in antibody titer in immune subjects (12), it was not deemed feasible in this study to attempt to evaluate this effect.

To obtain comparable figures for older age groups, the test was also offered to, but not urged upon, the school faculty and lay personnel assisting with the testing. For each person tested the following information was obtained:

name, school, sex, race, birth date, and lifelong residence in Montgomery County.

Information as to previous diphtheria immunization was not requested because of the large error in reporting to be expected from such a group as demonstrated by Geiger and associates in their San Francisco study of 1947-48 (13). It was further thought to be unnecessarily time consuming to seek such information from previous school medical records.

Schick Test Results

In the 9 schools with a total enrollment of 1,862 in the senior classes, 1,286 students were tested. Of these, 102, or 7.9 percent, had positive reactions (table 1). This figure is considerably lower than has been reported in similar age groups by other investigators (14-19). An additional 64, or 4.9 percent, had reactions of less than 10 mm., but the majority of these were of less than 4 mm. Since readings were taken at 48 or 72 hours, these probably represented local reaction to the trauma of injection rather than true mild reactions to the toxin, as there was an even greater number of similar minor reactions at the control site.

Of the 110 adults tested, 42, or 38 percent, were positive. This figure approximates those reported in naval recruits (20, 21), in soldiers (10, 22), and in medical students (14). All of these studies, however, dealt primarily with young adults. Sensitivity reactions were more frequent among the adults, as was to be expected, and the severity of such reactions was much greater (14, 16). In at least 3 instances in this study, adults with positive reactions still complained of pruritus and induration 2 months after the testing.

All students with positive Schick reactions

Table 1. Results of Schick tests, Montgomery County, Md., 1957

Participants	Negative Schick and control		Positive Schick		Negative Schick, positive control	
	Number	Percent	Number	Percent	Number	Percent
Students.....	908	70.6	102	7.9	276	21.5
Adults.....	49	44.5	42	38.2	19	17.3
Total.....	957	68.6	144	10.3	295	21.1

Table 2. Schick reactors by sex and race, Montgomery County, Md., 1957

Reactions	Students								Adults			
	White		Nonwhite		Female		Male		Female		Male	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Positive.....	96	7.8	6	9.8	46	7.0	56	8.9	23	40.3	19	35.8
Negative.....	1,129	92.2	55	90.2	611	93.0	573	91.1	34	59.7	34	64.2
Total.....	1,225	100	61	100	657	100	629	100	57	100	53	100

were referred to their private physician for immunization at his discretion. Because of increased sensitivity to diphtheria toxoid and the questioned significance of a single Schick test in an adult as an indication for toxoid administration (14), adults were cautioned about the possible consequences of requesting immunization and were advised to consult with their physician and to follow his advice. Approximately 2 months after completion of the testing program, a survey of all Schick positive students revealed that only 43 of 102 had contacted their doctors, and 27 of these had received immunizations. In addition, it is known that at least 7 of the adult group received toxoid.

Of 61 Negro students tested, 6, or 9.8 percent, had positive reactions. This is not significantly different from the 7.8 percent positive rate found in 1,225 white students. The reactor rate for all male students was 8.9 percent and for females 7.0 percent (table 2); however, this difference is of doubtful statistical significance.

In the adult group, the reverse was true; males 35.8 percent, females 40.3 percent. It is felt that the relatively increased immunity of the adult male over the female is due to the fact that the males tested were, in general, younger than the females.

Analyzing the reactor rates by age (table 3), a definite rise in the reactor rate with increasing age is evident. It must be recognized, however, that the spread of ages was heavily concentrated in 17- and 18-year olds, with 60 percent and 23 percent, respectively, of the total tested falling in these age groups.

The decreasing levels of immunity with increasing age, evident in this study, is the antithesis of that reported in school children in Baltimore in 1928 (17), and in New York in 1921 (23), when immunity to diphtheria was principally due to natural exposure to *C. diphtheriae* rather than having been artificially produced.

Because of the marked differences in socioeco-

Table 3. Percentage of positive Schick reactions by age and sex, Montgomery County, Md., 1957

Age	Number tested	Number positive	Percent positive	Males positive		Females positive	
				Number	Percent	Number	Percent
16.....	66	3	4.6	0	0	3	4.6
17.....	838	69	8.2	38	4.5	31	3.7
18.....	321	27	8.4	17	5.3	10	3.1
19.....	38	3	7.9	2	5.3	1	2.6
20-29.....	34	5	14.7	2	5.9	3	8.8
30-39.....	38	12	31.8	8	21.0	4	10.5
40-49.....	33	18	54.9	7	21.2	11	33.3
50 and over.....	13	7	53.8	1	7.6	6	46.1
Not listed.....	15	0	-----	-----	-----	-----	-----
All ages.....	1,396	144	10.3	75	10.9	69	9.6

conomic factors between urban and rural sections of Montgomery County, a higher degree of immunity was anticipated for the urban area with its greater availability of medical supervision. Actually, however, the rate of immunity in the 3 largest schools serving the urban segment of the county is insignificantly lower than that in the remaining 6 schools in the more rural areas, which included the 1 all Negro school with the highest rate of any. On the other hand, the spread between the two largest schools with apparently similar population groups was from 6.2 percent to 9.2 percent positive reactors.

To the question, "Allowing for up to 6 months absence, have you always lived in Montgomery County?" 870 students (68 percent) and 100 adults (91 percent) answered negatively. There was no significant difference between the answers of the Schick reactors (students, 65 percent; adults, 90 percent) and the nonreactors (students, 68 percent; adults, 91 percent). This indicates that the marked immigration into the county has not introduced a new susceptible group into a relatively immune population, as has been demonstrated before some epidemics (23).

Conclusions

The principal conclusion to be drawn from the data is that regardless of whatever minor differences in immunity levels among the students might occur on the basis of age, sex, race, length of residence, or rural-urban location, the Schick reactor rate in Montgomery County high school seniors is low. It compares quite favorably with the 23 percent reported in San Francisco (13), and 17 percent in York, Pa. (8).

The senior high school population, therefore, is quite well protected against diphtheria and the occurrence of more than sporadic cases is unlikely. The adults in the school population, on the other hand, are significantly less immune. In addition to the annual evaluation of immunization among preschool children, it might be well to sample regularly, at perhaps 5-year intervals, the diphtheria immunity of the teen-aged groups and young and middle-aged adults.

Such periodic evaluation may well evidence that since infant and preschool immunization

in this particular community is accepted practice, the facilities and efforts of the health department and medical profession should be directed toward maintaining high levels of immunity in the adult population.

In considering this possibility we must remain aware of the high levels of sensitivity to diphtheria toxoid. Edsall and associates report on the use of minute amounts (1 to 2 Lf) of highly purified diphtheria toxoid in combination with tetanus toxoid (25). Such combination has been used by the Armed Forces for approximately 3 years and has recently become commercially available as "tetanus-diphtheria toxoid, for adult use."

It is probable that because of the low incidence of cases of diphtheria and, therefore a decreased incidence of carriers of virulent diphtheria organisms, active, natural immunization is not occurring with any great frequency. The high degree of immunity demonstrated probably represents a carryover of significant protection from preschool immunizations. Immunization in the adult population, however, when performed was done with antigens, presumably less effective than those now available, and the lack of reinforcing exposures to the organism may be of greater importance.

Summary

In January and February 1957, 1,286 Montgomery County, Md., 12th graders and 110 adults were given Schick tests with control tests. The Schick positive rate for the students was 7.9 percent and for the adults, 38 percent. No statistically significant correlation was found for race, sex, or residence.

The results suggest the need for periodic sampling of diphtheria immunity among teen-aged and adult segments of the population.

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London Seminar in Health Education

An international seminar on the principles, methods, and media of health education was held in London, England, April 22-25, 1958, under the sponsorship of the Central Council of Health Education.

The program covered the philosophy and practice of health education through theoretical lectures, group discussions, and practical demonstration of techniques. Scheduled subjects were planning the program, choosing the methods, selecting the means, use of equipment, and mass media in health education.